CLAIMS

1. An apparatus for producing a fiber-cement soffit from a fiber-cement panel, comprising:

a punch assembly having a punch plate and a plurality of punches coupled to the punch plate, each punch having a length and a first cross-sectional dimension in a plane generally parallel to the length of the punch;

a support assembly having a support plate, at least a portion of the support plate being juxtaposed to at least a portion of the punch plate along a punch path to define a juxtaposed portion of the support plate, the support plate having a plurality of holes, wherein each hole in the juxtaposed portion is aligned with a corresponding punch, and wherein each hole has a second cross-sectional dimension greater than the first cross-sectional dimension to define a radial punch/hole clearance between each punch and each hole that is sufficient to allow the punches to be removed from the fiber-cement panel without delaminating portions of the fiber-cement panel; and

an actuator operatively coupled to the punches and/or the support plate to move the punches and/or the support plate between a first position and a second position, the punches being spaced apart from the support plate in the first position to receive at least a portion of the fiber-cement panel between the punches and the support plate, and the punches penetrating into at least a portion of the fiber-cement panel in the second position to form apertures in the fiber-cement panel corresponding to approximately the size and shape of the punches on at least one side of the panel.

2. The apparatus of claim 1 wherein:

the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a concave contact face, and a first diameter defining the first cross-sectional dimension of approximately 0.11-0.25 inch;

the support plate comprises a second flat plate and the holes have a second diameter defining the second cross-sectional dimension of approximately 0.18-0.39 inch;

the clearance between the punches and the holes is approximately 0.032-0.150 inch; and

the actuator comprises a linear actuator coupled to the punch plate.

3. The apparatus of claim 1 wherein:

the punch plate is a cylindrical plate having an interior cavity and a plurality of punch cavities spaced apart from one another by approximately 0.5-1.0 inch, the cylindrical plate being rotatable so that a set of punch cavities along an axial row of the cylindrical plate rotates into a punch position juxtaposed to a corresponding set of holes in the support plate;

the punches comprise a plurality of rods moveably coupled to the cylindrical plate, each rod being at least partially received in a corresponding punch cavity in the cylindrical plate and biased inwardly toward the interior cavity, and each rod having a first end with a head in the interior cavity and a second end opposite the first with a contact face, wherein the rods and the punch cavities are configured into punch sets along rows extending along the axial length of the cylindrical punch plate, and an active punch set is defined by a particular row of punches momentarily juxtaposed to the holes in the support plate as the cylindrical plate rotates; and

the actuator comprises a ram having an engagement surface configured to contact the heads of punches in the active punch set as the active punch set rotates into alignment with the holes in the support structure, the actuator driving the punches in the active rod set through the openings in the cylindrical plate and into the fiber-cement.

4. The apparatus of claim 1 wherein the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch defining the first cross-sectional dimension; and

the clearance between the punches and the holes is approximately 0.04-0.07 inch.

5. The apparatus of claim 1 wherein the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a concave contact face, and a first diameter defining the first cross-sectional dimension of approximately 0.11-0.25 inch;

the holes in the support plate have a second diameter defining the second cross-sectional dimension of approximately 0.18-0.39; and

the clearance between the punches and the holes is approximately 0.04-0.07 inch.

6. The apparatus of claim 1 wherein the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a concave contact face, and a first diameter defining the first cross-sectional dimension;

the holes in the support plate have a second diameter defining the second cross-sectional dimension; and

the clearance between the punches and the holes is approximately 4%-30% of the second diameter.

7. The apparatus of claim 1 wherein the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a concave contact face, and a first diameter defining the first cross-sectional dimension;

the holes in the support plate have a second diameter defining the second cross-sectional dimension; and

the clearance between the punches and the holes is approximately 23%-27% of the second diameter.

8. The apparatus of claim 1 wherein the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a flat contact face, and a first diameter defining the first cross-sectional dimension;

the holes in the support plate have a second diameter defining the second cross-sectional dimension; and

the clearance between the punches and the holes is approximately 23%-27% of the second diameter.

9. An apparatus for producing a fiber-cement soffit from a fiber-cement panel, comprising:

a punch assembly having a punch plate and a plurality of punches projecting from the plate, each punch having a first cross-sectional dimension;

a support assembly having a support plate juxtaposed to the punch plate along a punch path, the support plate having a plurality of holes, each hole being aligned with a corresponding punch, and each hole having a second cross-sectional dimension greater than the first cross-sectional dimension to define a radial punch/hole clearance between each punch and each hole of at least 0.04-0.07 inch; and

an actuator operatively coupled to the punch plate and/or the support plate to move the punch plate and/or the support plate between a first position and a second position, the punches being spaced apart from the support plate in the first position to receive the fiber-cement panel between the punches and the support plate, and the punches penetrating to at least an intermediate depth of the fiber-cement panel in the second position to form

apertures in the fiber-cement panel corresponding to approximately the size and shape of the punches.

10. The apparatus of claim 9 wherein the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a concave contact face, and a first diameter defining the first cross-sectional dimension of approximately 0.11-0.25 inch; and

the holes in the support plate have a second diameter defining the second cross-sectional dimension of approximately 0.18-0.39.

11. The apparatus of claim 9 wherein the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a concave contact face, and a first diameter defining the first cross-sectional dimension;

the holes in the support plate have a second diameter defining the second cross-sectional dimension; and

the clearance between the punches and the holes is approximately 4%-30% of the second diameter.

12. The apparatus of claim 9 wherein the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a concave contact face, and a first diameter defining the first cross-sectional dimension;

the holes in the support plate have a second diameter defining the second cross-sectional dimension; and

the clearance between the punches and the holes is approximately 23%-27% of the second diameter.

13. The apparatus of claim 9 wherein the punch plate comprises a first flat plate and the punches comprise elongated studs spaced apart from one another by approximately 0.5-1.0 inch, the studs having a first end attached to the flat plate, a second end opposite the first end with a flat contact face, and a first diameter defining the first cross-sectional dimension;

the holes in the support plate have a second diameter defining the second cross-sectional dimension; and

the clearance between the punches and the holes is approximately 23%-27% of the second diameter.

14. The apparatus of claim 9 wherein the radial punch/hole clearance between each punch and each hole is from approximately 0.0575-0.0675 inch.

15. An apparatus for producing a fiber-cement soffit from a fiber-cement panel, comprising:

a punch assembly having a punch plate and a plurality of punches projecting from the plate, each punch having a first cross-sectional dimension;

a support assembly having a support plate juxtaposed to the punch plate along a punch path, the support plate having a plurality of holes, each hole being aligned with a corresponding punch, and each hole having a second cross-sectional dimension greater than the first cross-sectional dimension to define a radial punch/hole clearance between each punch and each hole from approximately 4%-30% of the second cross-sectional dimension; and

an actuator operatively coupled to the punch plate and/or the support plate to move the punch plate and/or the support plate between a first position and a second position, the punches being spaced apart from the support plate in the first position to receive the

fiber-cement panel between the punches and the support plate, and the punches penetrating to at least an intermediate depth of the fiber-cement panel in the second position to form apertures in the fiber-cement panel corresponding to approximately the size and shape of the punches.

16. An apparatus for producing a fiber-cement soffit from a fiber-cement panel, comprising:

a punch assembly having a punch plate and a plurality of punches projecting from the plate, each punch having a first cross-sectional dimension;

a support assembly having a support plate juxtaposed to the punch plate along a punch path, the support plate having a plurality of holes, each hole being aligned with a corresponding punch, and each hole having a second cross-sectional dimension greater than the first cross-sectional dimension to define a radial punch/hole clearance between each punch and each hole of approximately 4%-40% of a thickness of the fiber-cement panel; and

an actuator operatively coupled to the punch plate and/or the support plate to move the punch plate and/or the support plate between a first position and a second position, the punches being spaced apart from the support plate in the first position to fit the fiber-cement panel between the punches and the support plate, and the punches penetrating into at least a portion of the fiber-cement panel in the second position to form apertures in the fiber-cement panel corresponding to approximately the size and shape of the punches.

17. A method of fabricating a fiber-cement soffit, comprising:

placing a fiber-cement panel between a punch assembly and a support assembly, the punch assembly having a punch plate and a plurality of punches coupled to the punch plate, and the support assembly having a support plate with a plurality of holes; and

driving the punches at least substantially simultaneously into and through at least a portion of the fiber-cement panel to form a plurality of apertures in

the fiber-cement panel by ejecting plugs from the fiber-cement panel through the holes in the support surface.

18. The method of claim 17 wherein driving the punches comprises penetrating the punches into the fiber-cement panel to an intermediate depth of the fiber-cement panel without passing the punches completely through the panel.

19. The method of claim 17 wherein the fiber-cement panel has a thickness of approximately 0.25-0.31635 inch, and wherein driving the punches comprises penetrating the punches into the panel to a depth of approximately 0.0625-0.9375 inch without passing the punches completely through the panel.

20. The method of claim 17 wherein:

the punch assembly includes a flat punch plate and the plurality of punches project from the punch plate, the punches being spaced apart from one another by approximately 0.5-1.0 inch, and the punches having a first end attached to the punch plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch;

the support assembly includes a flat support plate and the plurality of holes extend through the support plate, each hole being aligned with a corresponding punch projecting from the punch plate, and the holes having a second diameter of approximately 0.18-0.39 inch to provide a radial punch/hole clearance between the punches and holes of approximately 0.04-0.07 inch; and

driving the punches comprises moving the punches toward the holes and into the fiber-cement panel until the punches eject the plugs from the panel.

21 The method of claim 17 wherein:

the punch assembly includes a flat punch plate and the plurality of punches project from the punch plate, the punches being spaced apart from one another by approximately 0.5-1.0 inch, and the punches having a first end attached to the punch plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch;

the support assembly includes a flat support plate and the plurality of holes extend through the support plate, each hole being aligned with a corresponding punch projecting from the punch plate, and the holes having a second diameter of approximately 0.18-0.39 inch to provide a radial punch/hole clearance between the punches and holes of approximately 4%-30% of the second diameter of the holes; and

driving the punches comprises moving the punches toward the holes and into the fiber-cement panel until the punches eject the plugs from the panel.

22. The method of claim 17 wherein:

the punch assembly includes a flat punch plate and the plurality of punches project from the punch plate, the punches being spaced apart from one another by approximately 0.5-1.0 inch, and the punches having a first end attached to the punch plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch;

the support assembly includes a flat support plate and the plurality of holes extend through the support plate, each hole being aligned with a corresponding punch projecting from the punch plate, and the holes having a second diameter of approximately 0.18-0.39 inch to provide a radial punch/hole clearance between the punches and holes of approximately 4%-40% of a thickness of the fiber-cement panel; and

driving the punches comprises moving the punches toward the holes and into the fiber-cement panel until the punches eject the plugs from the panel.

23. A method of fabricating a fiber-cement soffit, comprising:

placing a fiber-cement panel between a punch assembly and a support assembly, the punch assembly having a punch plate and a plurality of punches coupled to the punch plate, and the support assembly having a support plate with a plurality of holes;

driving the punches at least substantially simultaneously into and through at least a portion of the fiber-cement panel to form apertures in the fiber-cement panel by ejecting plugs from the fiber-cement panel through the holes in the support surface; and

withdrawing the punches from the fiber-cement panel without delaminating the fiber-cement panel at the apertures.

24. The method of claim 23 wherein driving the punches comprises penetrating the punches into the fiber-cement panel to an intermediate depth of the fiber-cement panel without passing the punches completely through the panel.

25. The method of claim 23 wherein the fiber-cement panel has a thickness of approximately 0.25-0.31635 inch, and wherein driving the punches comprises penetrating the punches into the panel to a depth of approximately 0.0625-0.9375 inch without passing the punches completely through the panel.

26. The method of claim 23 wherein:

the punch assembly includes a flat punch plate and the plurality of punches project from the punch plate, the punches being spaced apart from one another by approximately 0.5-1.0 inch, and the punches having a first end attached to the punch plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch;

the support assembly includes a flat support plate and the plurality of holes extend through the support plate, each hole being aligned with a corresponding punch projecting from the punch plate, and the holes having a second diameter of approximately 0.18-0.39 inch to provide a radial punch/hole clearance between the punches and holes of approximately 0.04-0.07 inch; and

driving the punches comprises moving the punches toward the holes and into the fiber-cement panel until the punches eject the plugs from the panel.

27 The method of claim 23 wherein:

the punch assembly includes a flat punch plate and the plurality of punches project from the punch plate, the punches being spaced apart from one another by approximately 0.5-1.0 inch, and the punches having a first end attached to the punch plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch;

the support assembly includes a flat support plate and the plurality of holes extend through the support plate, each hole being aligned with a corresponding punch projecting from the punch plate, and the holes having a second diameter of approximately 0.18-0.39 inch to provide a radial punch/hole clearance between the punches and holes of approximately 4%-30% of the second diameter of the holes; and

driving the punches comprises moving the punches toward the holes and into the fiber-cement panel until the punches eject the plugs from the panel.

28. The method of claim 23 wherein:

the punch assembly includes a flat punch plate and the plurality of punches project from the punch plate, the punches being spaced apart from one another by approximately 0.5-1.0 inch, and the punches having a first end attached to the punch plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch;

the support assembly includes a flat support plate and the plurality of holes extend through the support plate, each hole being aligned with a corresponding punch projecting from the punch plate, and the holes having a second diameter of approximately 0.18-0.39 inch to provide a radial punch/hole clearance between the punches and holes of approximately 4%-40% of a thickness of the fiber-cement panel; and

driving the punches comprises moving the punches toward the holes and into the fiber-cement panel until the punches eject the plugs from the panel.

29. The method of claim 23 wherein withdrawing the punches from the fiber-cement panel comprises pressing resilient biasing members against the fiber-cement panel adjacent to at least a subset of the plurality of punches when the punches penetrate into fiber-cement panel.

30. The method of claim 23, further comprising:

providing a plurality of biasing elements coupled to the punch assembly, the biasing elements being compressible, resilient members projecting from the punch plate adjacent to a punch; and

withdrawing the punches from the fiber-cement panel by pressing the biasing elements against the fiber-cement panel proximate to at least a subset of the punches as the punches penetrate the fiber-cement panel.

31. A method of fabricating a fiber-cement soffit, comprising:

placing a fiber-cement panel between a punch assembly and a support assembly, the punch assembly having a punch plate and a plurality of punches projecting from the punch plate, and the support assembly having a support plate with a plurality of holes; and

forming a plurality of apertures in the fiber-cement panel at least substantially simultaneously by driving the punches at least substantially

simultaneously through only a portion of the fiber-cement panel without passing the punches completely through the panel.

32. The method of claim 31 wherein the fiber-cement panel has a thickness of approximately 0.25-0.31635 inch, and wherein driving the punches comprises penetrating the punches into the panel to a depth of approximately 0.0625-0.9375 inch without passing the punches completely through the panel.

33. The method of claim 31 wherein:

the punch assembly includes a flat punch plate and the plurality of punches project from the punch plate, the punches being spaced apart from one another by approximately 0.5-1.0 inch, and the punches having a first end attached to the punch plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch;

the support assembly includes a flat support plate and the plurality of holes extend through the support plate, each hole being aligned with a corresponding punch projecting from the punch plate, and the holes having a second diameter of approximately 0.18-0.39 inch to provide a radial punch/hole clearance between the punches and holes of approximately 0.04-0.07 inch; and

driving the punches comprises moving the punches toward the holes and into the fiber-cement panel until the punches eject the plugs from the panel.

34 The method of claim 31 wherein:

the punch assembly includes a flat punch plate and the plurality of punches project from the punch plate, the punches being spaced apart from one another by approximately 0.5-1.0 inch, and the punches having a first end attached to the punch plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch;

the support assembly includes a flat support plate and the plurality of holes extend through the support plate, each hole being aligned with a corresponding punch projecting from the punch plate, and the holes having a second diameter of approximately 0.18-0.39 inch to provide a radial punch/hole clearance between the punches and holes of approximately 4%-30% of the second diameter of the holes; and

driving the punches comprises moving the punches toward the holes and into the fiber-cement panel until the punches eject the plugs from the panel.

35. The method of claim 31 wherein:

the punch assembly includes a flat punch plate and the plurality of punches project from the punch plate, the punches being spaced apart from one another by approximately 0.5-1.0 inch, and the punches having a first end attached to the punch plate, a second end opposite the first end with a concave contact face, and a first diameter of approximately 0.11-0.25 inch;

the support assembly includes a flat support plate and the plurality of holes extend through the support plate, each hole being aligned with a corresponding punch projecting from the punch plate, and the holes having a second diameter of approximately 0.18-0.39 inch to provide a radial punch/hole clearance between the punches and holes of approximately 4%-40% of a thickness of the fiber-cement panel; and

driving the punches comprises moving the punches toward the holes and into the fiber-cement panel until the punches eject the plugs from the panel.

36. The method of claim 31 wherein withdrawing the punches from the fiber-cement panel comprises pressing resilient biasing members against the fiber-cement panel adjacent to at least a subset of the plurality of punches when the punches penetrate into fiber-cement panel.

37. The method of claim 31, further comprising:

providing a plurality of biasing elements coupled to the punch assembly, the biasing elements being compressible, resilient members projecting from the punch plate adjacent to a punch; and

withdrawing the punches from the fiber-cement panel by pressing the biasing elements against the fiber-cement panel proximate to at least a subset of the punches as the punches penetrate the fiber-cement panel.